Utilization of GOES Rapid-Scan Wind Data for Tropical Cyclone Predictability Experiments

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LONG-TERM GOALS

The overarching goal is to obtain special data sets of geostationary satellite rapid-scan (RS) atmospheric motion vectors (AMV) to assimilate and test for improvements in NAVY global numerical model (NOGAPS) forecasts of tropical cyclones (TC) using targeting information provided by NRL-MRY. There is the potential for forecast benefits with the R/S-AMV since the higher image frequency yields more accurate observations in comparison to routinely-produced AMV data. This is the motivation for this investigation.

OBJECTIVES

The past year's efforts have focused on using the experimental RS datasets in satellite data assimilation trials to test for predictability impacts on NOGAPS forecasts of TC tracks and intensity.

APPROACH

RS-AMV from GOES-12 VIS and IR imagery (7.5 minute image intervals) processed by CIMSS are being used for this study. To-date, AMV assimilation has not generally benefited from good knowledge of observation errors. New quality control (QC) indices under development at CIMSS are being applied to the RS-AMV, and this information is being tested for estimates of AMV accuracy and estimated correlated error, which in turn can be employed to improve super-ob or thinning procedures used to assimilate the AMV into NOGAPS.

A comprehensive evaluation of the RS-AMV data is being conducted using NOGAPS predictions of targeted TCs to determine observation impact on measures of forecast quality. Of special interest are experiments where the R/S datasets are partitioned and only assimilated into the NRL targeted regions to assess the sensitivity of targeted observing approaches on NOGAPS TC track/intensity forecasts.

WORK COMPLETED

In this reporting period, initial data assimilation trials have commenced. Co-I Berger spent 6 weeks at NRL-MRY working with Rolf Langland and others to set up further experiments.

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14. ABSTRACT
The overarching goal is to obtain special data sets of geostationary satellite rapid-scan (RS) atmospheric motion vectors (AMV) to assimilate and test for improvements in NAVY global numerical model (NOGAPS) forecasts of tropical cyclones (TC) using targeting information provided by NRL-MRY. There is the potential for forecast benefits with the R/S-AMV since the higher image frequency yields more accurate observations in comparison to routinely-produced AMV data. This is the motivation for this investigation.

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RESULTS

Experiments were first conducted for April, 2007 with routine AMVs in the Navy NOGAPS model. Two experiments tested the use of the new Expected Error (EE) quality indicator. The first used two thresholds (one for slow winds, a higher one for fast winds) to test the EE's skill in removing bad AMVs from the analysis. The second experiment set the observation error of the AMV to the EE. Both of these experiments showed only slight impacts (Fig. 1).

A third experiment utilized the adjoint impact estimation (Langland and Baker, 2004) calculated for the AMVs. From this tool, it was shown that the AMVs had maximum positive impact when their observation errors were set to 1.5 times the background error. Thus, we tested the impact of setting the observation errors to this ratio. This experiment had a small positive impact. These impacts can be seen in the upper-level temperature fields (Fig. 2), and lower level wind fields of the model.

The threshold experiment was a first test of the EE. The thresholds probably need to be retuned to optimize the use of the AMV quality indicator. Its impact may also be limited because it was only used for the CIMSS winds, not winds provided by other production centers. Performing this experiment on all of the AMVs (which is not currently possible) might increase the impact on the global system. The observation error ratio experiment was promising. It shows the power of the adjoint impact technique to modify all of the winds in the analysis system, and may be useful for further refining the AMV observation error values within the model.

IMPACT/APPLICATIONS

The work in this reporting period is setting the stage for a major field program in 2008 called TCS-08, which will aim to study TC structure in the western North Pacific. During this experiment, RS AMVs will be provided by the MTSAT satellite, and processed into AMVs by CIMSS. These datasets will then be provided to NRL-MRY and tested in the context of targeted observations, adaptive sampling, and optimized assimilation strategies with the goal of improving NOGAPS forecasts of TCs in the western North Pacific.

The basic hypothesis in this study is that regions of TC analyses that are sensitive to initial conditions can be successfully targeted, and when enhanced data are applied to those regions, the numerical forecasts will improve. If this theory is further proven in this study, it could have a significant impact on future operational procedures to observe TCs, provide a better understanding of the processes affecting track and motion, and improve their predictability.

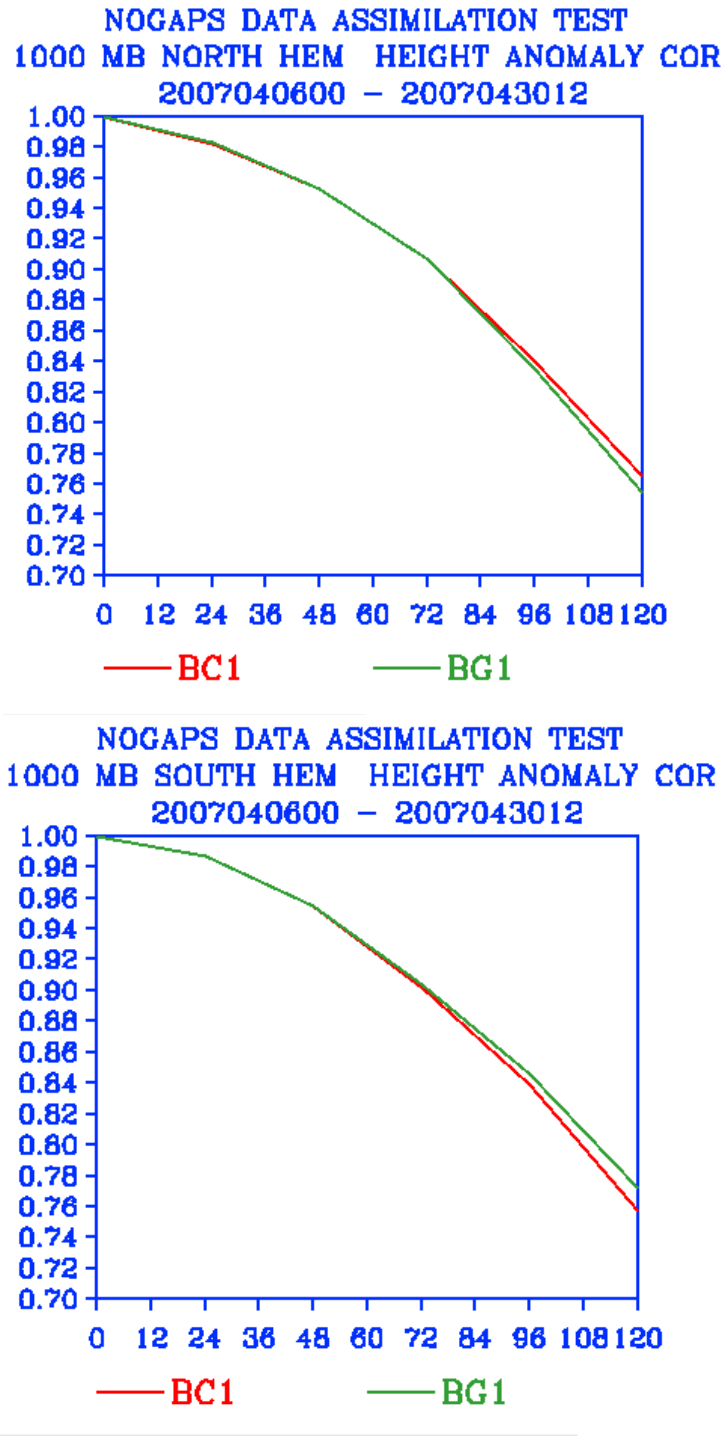

Figure 1: Average 1000 hPa height anomaly correlations for the control (BC1) and EE threshold experiment (BG1) for both northern (top plot) and southern (bottom plot) hemisphere.

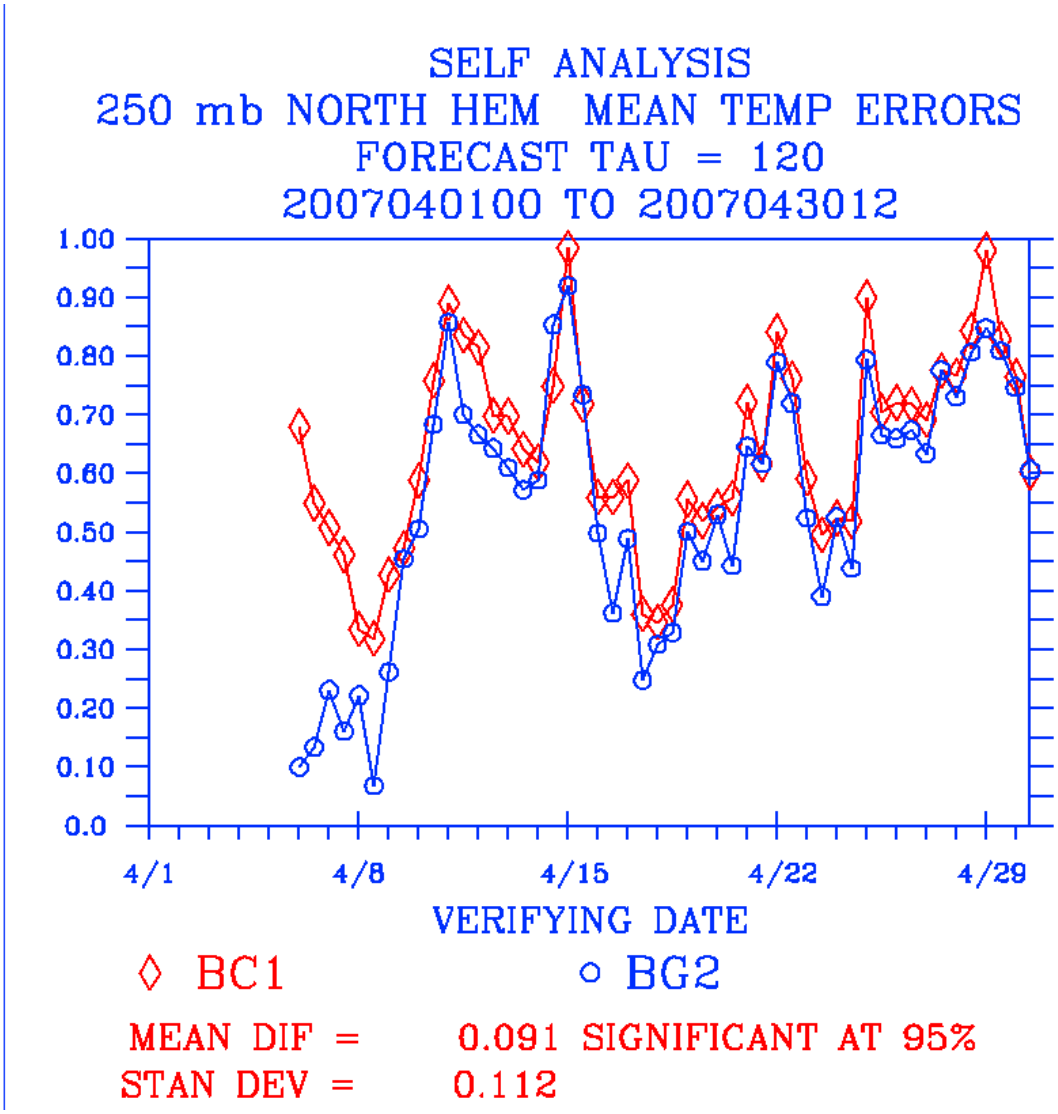

Figure 2: Mean temperature error time series at 250 hPa for Observation Error ratio experiment (BG2) compared to the control (BC1). The BG2 experiment has significantly lower temperature errors compared to the control.